Raghav Arora

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RAraghavarora

Education

2017–2022 **B.E. (Hons.) - Electrical and Electronics Engineering + MSc.(Hons.) Chemistry**, *Birla Institute of Technology and Science*, Pilani, *(CGPA: 8.86)*.

2017 **CBSE (Class XII)** , *KV ONGC*, Dehradun, *(Percentage: 88%)*.

2015 **ICSE (Class X)** , *St. Thomas' College*, Dehradun, *(Percentage: 91.6%)*.

Research Projects

Object Rearrangement using Embodied AI (ongoing)
Guide: Prof. K Madhava Krishna

- This research endeavour aspires to resolve the room rearrangement task.
- An agent is trained for rearranging various misplaced objects in a room to bring the scene to a specified state. I am using Commonsense Reasoning based on Large Language Models(LLM) to automatically detect misplaced objects. Object instances are recognized using Mask2Former and mapped to object embeddings generated by CLIP. Using this framework, we construct a continuous scene representation from RGB images as the agent explores the scene and the object relational embeddings are learnt on the fly.
- This novel approach exploits affinity score for generating probability distribution of objects and receptacles in a scene.

Deep learning for quantum chemistry using Density Functional Tight-Binding Method
Guide: Prof. Alexandre Tkatchenko

- This project leveraged machine learning for generating a well modeled chemical compound space that maps chemical properties of molecules to their molecular structure.
- I worked on developing novel molecular descriptors to mathematically encode molecules in a way that can be input to neural networks. In this method, existing geometric descriptors are combined with electronic properties obtained from semi-empirical quantum-chemistry methods to generate appropriate molecular representation. I designed Deep Learning architectures to use the molecular descriptors for predicting different physico-chemical properties.
- With a focus on transferability and scalability of ML models, this project aimed to improve the prediction of properties, which is crucial for drug discovery.

Investigation of image mosaicing techniques for UAV navigation
Guide: Prof. Meetha V. Shenoy

- In this project, multiple aerial images captured by Unmanned Aerial Vehicles are stitched together in real time using image registration and blending algorithms.
- The project started with the literature review of existing image mosaicing techniques for navigation of unmanned aerial vehicles, followed by the performance comparison of the algorithms. Using a combination of SIFT(Scale Invariant Feature Transform) and SURF(Speeded Up Robust Features) feature descriptors, patterns between the images are detected. RANSAC variation of BaySac algorithm is used for seamlessly blending the images.
- The new image hence generated can be used for the navigation of swarm of small robots.

Real-Time Single Image and Video Super-Resolution
Guide: Dr. Surekha Bhanot

- For conversion of Low Resolution Images to High Resolution, traditional approaches make use of interpolation to upscale the image in the 1st step, which makes the entire process computationally extensive.
- This project makes use of an efficient sub-pixel convolutional layer, which is the last layer of the CNN for upscaling the image. Hence, the process becomes computationally fast, and can be used for real-time applications.

Molecular Dynamics Simulations for Room Temperature Ionic Liquids
Guide: Prof. Prashant U. Manohar

- Laboratory oriented project to simulate acetonitrile in the presence of room-temperature ionic liquids using Amber MD software, and present alternatives to traditional organic solvents.
- Multiple physical and chemical properties of ionic liquid [bmim][BF4] were analysed in the presence of acetonitrile to obtain their relative stability and the possibility of using RTILs as solvents was studied.

Publications

[1] Ayush Agrawal, **Raghav Arora**, Ahana Datta, Snehasis Banerjee, Brojeshwar Bhowmick, Krishna Murthy Jatavallabhula, Mohan Sridharan, and Madhava Krishna. **2023**. "CLIPGraphs: Multimodal Graph Networks to Infer Object-Room Affinities". In: *2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. IEEE. DOI: 10.48550/arXiv.2306.01540.

Workshops

Eastern European Machine Learning Summer School, 2023 Košice, Slovakia *July, 2023*

- I attended the 5th edition of the EEML summer school co-organized by Google DeepMind, ESET, and AIslovakIA.
- Comprised of lectures, hands-on tutorials, roundtables, and poster sessions.
- Featured top, world-class researchers, professors, and business actors as speakers.
- I presented our work on CLIPgraphs that combines commonsense domain knowledge, data-driven methods, and recent advances in multimodal learning to learn object-room affinities based on embeddings of the prior knowledge and the vision-language features.

Learning Projects

CityLearn-2022
A part of NeurIPS 2022 Competition, this challenge uses Reinforcement Learning to to coordinate the energy consumed by a list of buildings within a simulated micro-grid.

E-Wallet
Development RESTful APIs used by college students to make payments using the college app. It was used during college fest with a total participation of 4000 participants generating sales worth $30,000 in five days. Major drawback invovled a bug in the E-Wallet: race conditions. It took months of reading and rewriting the code to fix the bug, and ultimately, I made use of celery to make the firebase calls asynchronous to solve the problem.

Project Erlebnisse
Built an e-voting application using Ethereum Blockchain protocol and deployed it on Microsoft Azure, as a part of Microsoft Codefundopp. Gained expertise in blockchain, hashing algorithms and other security protocols. Hands-on experience with Solidity, blockchain technology internals, expertise on smart contracts.

Integrated Reports Management and Decision Support System	Built a system to generate customised reports and make a knowledge base using Information Retrieval technique for making necessary predictions using the library database at the Scientific Information and Resource Division (SIRD), IGCAR. The Decision Support System was developed through hypothesis testing around the library database using the Koha Library Management System.

Technical Skills

- Areas of interest: Robotics, Computer Vision, Reinforcement Learning
- Proficient in: Python, PyTorch, Keras, ROS, OpenCV, Git, LaTeX
- Familiar With: Verilog, Javascript, Blockchain, LTSpice, Arduino, Java, AmberMD

Relevant Courses

Computer Science	Neural Networks and Fuzzy Logic, Digital Image Processing, Applied Calculus, Linear Algebra, Probability and Statistics, Differential Equations, Optimization Techniques, Digital Design, Microprocessors and Interfacing
Electrical and Electronics	Control Systems, Electronic Devices, Electrical Machines, Microelectronic Circuits, Analog and Digital VLSI Design, Communication Systems, Analog Electronics, Power Electronics, Power Systems
MOOCs	Introduction to Algorithms and Analysis, Learning from Data, Introduction to Programming with MATLAB